

REMARKS/ARGUMENTS

Favorable reconsideration of this application in light of the following discussion is respectfully requested. Claims 1-21 are pending.

In the outstanding Office Action, Claims 1-8, 10-12, and 15-21 were rejected as anticipated by Ogure et al. (U.S. Patent Application Publication No. 20010055649, hereinafter "Ogure"); Claim 9 was rejected as unpatentable over Ogure; and Claims 13 and 14 were rejected as unpatentable over Ogure in view of Ono et al. (U.S. Patent No. 5,108,535, hereinafter "Ono").

Initially, applicants and applicants' representatives thank Primary Examiner Olsen for the interview held on June 9, 2006 to discuss the present case. During the interview, differences between the claimed invention and Ogure were discussed in detail. Examiner Olsen agreed to reconsider the rejections of record after formal submission of the present response.

With regard to the rejection of Claim 1 as unpatentable over Ogure, that rejection is respectfully traversed.

Claim 1 recites in part, "introducing a directional beam of neutral oxygen atoms having high kinetic energy" and "oxidizing the Cu-containing layer by exposure to the beam of oxygen atoms."

In contrast, Ogure describes a method where a beam of oxygen ions or oxygen radicals 617 is used to irradiate a wiring layer 613.<sup>1</sup> During the above-mentioned interview, Examiner Olsen stated that he interpreted "a beam of oxygen radicals" as described by Ogure as "a directional beam of neutral oxygen atoms." However, it is respectfully noted that a radical is not *necessarily* a neutral particle, as it may be an ion. For example, excerpts from the twelfth edition of Hawley's Condensed Chemical Dictionary are provided herewith that

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<sup>1</sup> See Ogure, paragraphs 164 to 166.

define “radical” as “An ionic group with one or more charges” or as a “free radical,” which is defined as “A molecular fragment having one or more unpaired electrons.” Thus, it is respectfully submitted that the description of “a beam of oxygen radicals” in Ogure describes a beam of oxygen particles with one or more unpaired electrons, which may or may not be neutral particles. Accordingly, “a beam of oxygen radicals” is not “a directional beam of neutral oxygen atoms” as recited in Claim 1.

Further, it is noted that Ogure does describe a beam of neutral particles in paragraph 120, where a beam of neutral *nitrogen* particles is described, in contrast to paragraphs 164-166 of Ogure where a beam of oxygen radicals is described. Thus, it is respectfully submitted that the beam of oxygen radicals described in paragraphs 164-166 of Ogure is not necessarily neutral, as Ogure clearly described a beam of neutral nitrogen particles in paragraph 120.

Therefore, Ogure does not teach or suggest, either explicitly or inherently, “introducing a directional beam of neutral oxygen atoms having high kinetic energy” and “oxidizing the Cu-containing layer by exposure to the beam of oxygen atoms” as recited in Claim 1. Consequently, Claim 1 (and Claims 2-11 dependent therefrom) is patentable over Ogure.

Claim 12 recites in part, “a source of a directional beam of neutral oxygen atoms having high kinetic energies.” As noted above, Ogure does not teach or suggest the use of a beam of neutral oxygen atoms. Consequently, Claim 12 (and Claims 13-21 dependent therefrom) is also patentable over Ogure for at least the reasons described above with respect to Claim 1.

Claims 9 and 16 also recite subject matter that further defines over Ogure, in addition to being dependent from patentable Claims 1 and 12, respectively. Claims 9 and 16 recite that “the neutral oxygen atoms have kinetic energies between 10 eV and 1 eV.” In the

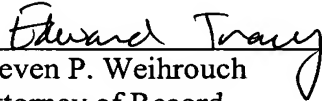
embodiment cited with regard to Claim 1, Ogure describes that the impinging particles have energies of 200 to 1,000 eV.<sup>2</sup> In fact, in paragraph 156, Ogure describes that particles must have an energy of *at least 30 eV* to be used in the invention described by Ogure. Thus, not only does Ogure fail to teach or suggest the subject matter of Claims 9 and 16, Ogure clearly teaches away from these inventions. Accordingly, Claims 9 and 16 further define patentably over Ogure.

With regard to the rejection of Claims 13 and 14 as unpatentable over Ogure in view of Ono, it is noted that Claims 13 and 14 are dependent from Claim 12, and thus are believed to be patentable for at least the reasons discussed above. Further, it is respectfully submitted that Ono does not cure any of the above-noted deficiencies of Ogure. Accordingly, it is respectfully submitted that Claims 13 and 14 are patentable over Ogure in view of Ono.

Consequently, in light of the foregoing comments, it is respectfully submitted that the invention defined by Claims 1-21 patentably distinguishes over the cited art. The present application is therefore believed to be in condition for formal allowance and an early and favorable reconsideration of this application is therefore respectfully requested.

Respectfully submitted,

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<sup>2</sup>See Ogure, paragraph 168.

U.S. Serial No. 10/517,764  
APPENDIX

*Hawley's*  
*Condensed Chemical*  
*Dictionary*

*TWELFTH EDITION*

*Revised by*  
Richard J. Lewis, Sr.

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the shortest wavelength being the most penetrating. They are not electrically charged and have no mass, their velocity of propagation is the same, all display the properties characteristic of light and have a dual nature (wave-like and corpuscular). In a looser sense the term "radiation" also includes energy emitted in the form of particles that possess mass and may or may not be electrically charged, i.e.,  $\alpha$  (positive) and  $\beta$  (negative), and neutrons. Beams of such particles may be considered as "rays." The charged particles may all be accelerated and high energy imparted to "beams" in particle accelerators such as cyclotrons, betatrons, synchrotrons, and linear accelerators.

Radiation is used in medicine in the form of x-rays and radioactive isotopes; it is used in industry in many ways, e.g., as a vitamin activator, sterilizing agent, and polymerization initiator; it is also the basis of all types of spectroscopic analysis.

See also following entries.

**radiation biochemistry.** The study of the chemical effects of ionizing radiation upon living tissue and of substances having the ability to protect cells and body tissue against the deleterious effects of ionizing radiation. Because one of these effects is to deprive proteins of sulfhydryl ( $-SH$ ) groups necessary for cell division, the injection of compounds rich in this radical (notably cysteine) has been successfully tried with laboratory animals. Thiourea has been found to protect DNA from depolymerization by x-rays; enzymes containing  $-SH$  groups inactivated by radiation are reactivated by addition of glutathione. Some of the other radiochemically induced reactions that adversely affect biochemical activity are (1) formation of hydrogen peroxide (a biological poison) by free-radical mechanisms, (2) denaturation of proteins, (3) change in substituent groups of amino acids, (4) oxidation of hemoglobin, (5) depolymerization of DNA.

See also radiation, ionizing.

**radiation curing.** See radiation, industrial (6).

**radiation, industrial.** Chemical or physiochemical changes induced by exposure to various types and intensities of radiation, including the following processes: (1) Synthesis of ethyl bromide from hydrogen bromide and ethylene, using  $\alpha$ -radiation from cobalt-60. (2) Cross-linking of such polymers as polystyrene and polyethylene with either  $\beta$  or  $\gamma$  radiation. (3) Vulcanization of rubber with ionizing radiation. (4) Polymerization of methyl methacrylate monomer with cobalt-60 as source of  $\gamma$ -rays. Free radical formation is involved in both cross-linking and polymerization reactions. This technique is also being applied in the textile finishing field for

grafting and cross-linking fibers with chemical agents for durable-press fabrics. (5) Processing of various foods (cooking, drying, pasteurizing, etc.) by electromagnetic energy in the microwave region of the spectrum; preservation and sterilization of food products by ionizing radiation ( $\gamma$ - and x-rays). The dosage of radiation is strictly controlled, and FDA approval is required.

Irradiation is also effective in inhibiting sprouting and preventing insect infestation of stored grains. (6) Curing or hardening of organic protective coatings (paints, inks) by exposure to infrared, UV or electron-beam radiation. Required are a monomer or oligomer and a photoinitiator, which induces polymerization by free radical formation.

See also "Electrocure."

**radiation, ionizing.** Extremely short-wavelength, highly energetic, penetrating rays of the following types: (1)  $\gamma$ -rays emitted by radioactive elements and isotopes (decay of atomic nuclei), (2) x-rays generated by sudden stoppage of fast-moving electrons, (3) subatomic charged particles (electrons, protons, deuterons) when accelerated in a cyclotron or betatron. The term is restricted to electromagnetic radiation at least as energetic as x-rays, and to charged particles of similar energies. Neutrons also may induce ionization.

Such radiation is strong enough to remove electrons from any atoms in its path, leading to the formation of free radicals. These short-lived but highly reactive particles initiate decomposition of many organic compounds. Thus, ionizing radiation can cause mutations in DNA and in cell nuclei; adversely affect protein and amino-acid mechanisms; impair or destroy body tissue; and attack bone marrow, the source of red blood cells. Exposure to ionizing radiation for even a short period is highly dangerous, and for an extended period may be lethal. The study of the chemical effects of such radiation is called radiation chemistry or (in the case of body reactions) radiation biochemistry.

See radiation, industrial, for applications.

**radical.** (1) An ionic group having one or more charges, either positive or negative, e.g.,  $OH^-$ ,  $NH_4^+$ ,  $SO_4^{2-}$ .

(2) See free radical; group (2).

**radioactive isotope.** See radioisotope.

**radioactive waste.** Disposal of waste containing radioisotopes and of spent nuclear reactor fuel presents a serious problem for which there is as yet no completely satisfactory solution. Such wastes may remain radioactive for thousands of

polymers) can be separated by a number of methods, including electrophoresis, gel filtration, chromatography, centrifugation, foam fractionation, and partition.  
See also reflux.

**fracturing, hydraulic.** See hydraulic fracturing.

**fragrance.** An odorant used to impart a pleasant smell to shaving lotions, toothpastes, men's accessories, etc.; balsamic and piny odors are typical.

**fraissite.** (benzyl iodide).  $C_6H_5CH_2I$ .  
Use: A tear gas.

**Franchimont reaction.** Carboxylic acid dimerization to 1,2-dicarboxylic acids by treating  $\alpha$ -bromocarboxylic acids with potassium cyanide followed by hydrolysis and decarboxylation.

**francium.** Fr. Element of atomic number 87, group IA of the periodic system, aw 223, valence = 1; it appears to exist only as radioactive isotopes. One isotope is actinium K ( $^{223}Fr$ ). Other isotopes have been made artificially:  $^{223}Fr$  is the longest-lived isotope having a half-life of 21 minutes and is the only natural isotope. Francium is the heaviest of the alkali-metal family.

**frankincense.** (olibanum). A gum resin.

**Frankland-Duppa reaction.** Formation of  $\alpha$ -hydroxycarboxylic esters by reaction of dialkyl oxalates with alkyl halides in the presence of zinc, or amalgamated zinc, and acid.

**Frankland synthesis.** Synthesis of zinc dialkyls from alkyl halides and zinc.

**franklinite.** (iron, manganese, zinc).  $(FeMn)_2O_4$ . Black mineral resembling magnetite.

**Frary metal.** A lead-based bearing metal containing 97-98% lead alloyed with 1-2% each of barium and calcium, excellent for low-pressure bearings at moderate temperatures.

**Frasch process.** A process by which much of the world's sulfur is obtained. Developed about 1900 by Herman Frasch, the process involves melting sulfur underground by introducing superheated water through a pipe under pressure and forcing the molten sulfur to the surface by compressed air.

**Fraunhofer lines.** See spectroscopy.

**free electron.** Electron not attached to any one atom and not restricted by potential gradients.

**free energy.** An exact thermodynamic quantity used to predict the maximum work obtainable from the spontaneous transformation of a given system. It also provides a criterion for the spontaneity of a transformation or reaction and predicts the greatest extent to which the reaction can occur, i.e., its maximum yield. Transformation of a system can be brought about by either heat or mechanical work. Free energy is derived from the internal energy and entropy of a system in accordance with the laws of thermodynamics.

**free radical.** A molecular fragment having one or more unpaired electrons, usually short-lived and highly reactive. In formulas, a free radical is conventionally indicated by a dot as  $Cl\cdot$ ,  $(C_2H_5)\cdot$ . In spite of their transitory existence, they are capable of initiating many kinds of chemical reactions by means of a chain mechanism. Free radicals are formed only by the splitting of a molecular bond. A chain can result only if (1) radicals attack the substrate and (2) the radicals lost by this reaction are regenerated. Chain mechanisms for the thermal decomposition of many substances have been established. Free radicals are known to be formed by ionizing radiation and thus play a part in deleterious degradation effects that occur in irradiated tissue. They also act as initiators or intermediates in such basic phenomena as oxidation, combustion, photolysis, and polymerization.  
See also carbonium ion.

**free sulfur.** Sulfur which is left chemically uncombined after vulcanization of a rubber compound. When this exceeds 1%, the upper limit of solubility of sulfur in rubber, blooming will occur. Most rubber products are vulcanized with as low a sulfur content as possible so that the free sulfur content of the product is seldom over 0.5%.  
See also bloom, vulcanization.

**freeze-drying.** (lyophilization). A method of dehydration or of separating water from biological materials. The material is first frozen and then placed in a high vacuum so that the water (ice) vaporizes in the vacuum (sublimes) without melting and the non-water components are left behind in an undamaged state.  
Use: Blood plasma, certain antibiotics, vaccines, hormone preparations, food products such as coffee and vegetables. One technique prepares freeze-dried ceramic pellets from water solutions of metal salts.

**"Freezene" [Witco].** TM for a series of refrigeration white mineral oils.  
Use: Low-temperature lubrication.

**freezing point.** See melting point.

## IODINE PENTOXIDE

642

**Hazard:** Dangerous fire risk, reacts violently with water. Toxic by ingestion and inhalation, corrosive to skin and mucous membranes. TLV (as F): 2.5 mg/m<sup>3</sup> of air.

**Use:** Fluorinating and incendiary agent.

**iodine pentoxide.** See iodic acid anhydride.

**iodine tincture.** A solution of iodine and potassium iodide or sodium iodide in alcohol, a reddish-brown liquid having the odors of iodine and alcohol, contains 44-50% by volume alcohol, 2 g of iodine and 2.4 g sodium iodide per 100 cc.

**Grade:** USP

**Hazard:** Toxic by ingestion, avoid using on open cuts.

**Use:** Antiseptic (use on skin surface only).

**iodine trichloride.** CAS: 865-44-1. ICl<sub>3</sub>.

**Properties:** Orange-yellow, deliquescent, crystalline powder; pungent irritating odor; soluble in water (with decomposition), alcohol, and benzene; mp 33C; d 3.11.

**Derivation:** By interaction of iodine and chlorine.

**Hazard:** Toxic by ingestion and inhalation, corrosive to tissue.

**Use:** Agent for introducing iodine and chlorine in organic synthesis; topical antiseptic.

**iodine value.** See iodine number.

**iodipamide.** CAS: 606-17-7.

(CH<sub>2</sub>)<sub>4</sub>(CONHC<sub>6</sub>H<sub>4</sub>COOH)<sub>2</sub>.

**Properties:** White, nearly odorless, crystalline powder; very slightly soluble in alcohol, chloroform, ether; insoluble in water; pH of saturated solution is 3.5-3.9.

**Hazard:** Toxic by ingestion.

**Use:** Medicine (x-ray contrast medium).

**iodisan.** See propiodal.

**iodized oil.** An iodine addition product of vegetable oil or oils containing 38-42% organically combined iodine.

**Properties:** Thick, viscous, oily liquid; affected by air and light; soluble in solvent naphtha.

**Hazard:** Toxic by ingestion.

**Use:** Medicine (radiopaque medium).

**iodoacetic acid, sodium salt.** (sodium iodoacetate). CAS: 305-53-3. ICH<sub>2</sub>CO<sub>2</sub>Na.

**Properties:** Colorless or white crystals with mw 207.93, mp 210C. Soluble in water, alcohol, and very slightly soluble in ether. Hygroscopic in moist air.

**Hazard:** Toxic.

**Use:** Analytical reagent.

**iodoethane.** See ethyl iodide.

**iodoethylene.** See tetraiodoethylene.

**iodoform.** (triiodomethane). CAS: 75-47-8.

CHI<sub>3</sub>.

**Properties:** Small greenish-yellow or lustrous crystals or powder, penetrating odor. Soluble in benzene and acetone; partially soluble in alcohol, glycerol, chloroform, carbon disulfide, and ether; insoluble in water. D 4.08, mp 115C.

**Derivation:** (1) By heating acetone or methanol with iodine in presence of an alkali or alkaline carbonates. (2) Electrolytically, by passing a current through a solution containing potassium iodide, alcohol, and sodium carbonate.

**Grade:** Technical, NF.

**Hazard:** Irritant, decomposes violently at 400F (204C). TLV: 0.6 ppm in air.

**Use:** Medicine (antiseptic for external use only).

**iodomethane.** See methyl iodide.

**1-iodooctadecane.** (octadecyl iodide).

CAS: 629-93-6. CH<sub>3</sub>(CH<sub>2</sub>)<sub>17</sub>I.

**Properties:** Solid with mw 380.40, mp 33-35C, bp 194-197C/2 mm Hg, fp 110C. Light-sensitive.

**Hazard:** Irritant.

**Use:** Reagent for introduction of C<sub>18</sub> chain.

**iodopanoic acid.** See iopanoic acid.

**iodophor.** ("tamed iodine"). (1) A complex of iodine with certain types of surface-active agents that have detergent properties. (2) More generally, any carrier of iodine.

**iodophosphonium.** See phosphonium iodide.

**2-iodopropane.** See isopropyl iodide.

**N-iodosuccinimide.** (succiniodimide).

CAS: 516-12-1. ((-CH<sub>2</sub>CO)<sub>2</sub>NI).

**Properties:** Colorless crystals, mp 200-201C, soluble in acetone and methanol; insoluble in carbon tetrachloride and ether, decomposes in water.

**Hazard:** Skin irritant.

**Use:** Iodinizing agent in synthetic organic chemistry.

**ion.** An atom or radical that has lost or gained one or more electrons and has thus acquired an electric charge. Positively charged ions are cations and those having a negative charge are anions. An ion often has entirely different properties from the element (atom) from which it was formed.

In sodium chloride solution, sodium exists as sodium ions (Na<sup>+</sup>), i.e., sodium atoms that have lost one electron. The chlorine is present as chloride ions (Cl<sup>-</sup>), i.e., chlorine atoms that have gained one electron. Copper sulfate solution



contains copper ions ( $\text{Cu}^{++}$ ), i.e., copper atoms that have lost two electrons, and sulfate ions ( $\text{SO}_4^{--}$ ), i.e., sulfate radicals that have gained two electrons.

Ions occur in water solution or in the fused state (except in the case of gases). Compounds that form ions are called electrolytes because they enable the solution to conduct electricity. Ion formation causes an abnormal increase in the boiling point of water and also lowers the freezing point, the extent depending on the concentration of the solution. Ions are also formed in gases as a result of electrical discharge. See also ionization, electrolysis, ion exchange.

**ion electrode.** Electrode that develops and measures an electrical potential in response to the activity of an ion in solution to which it is selective.

**ion exchange.** A reversible chemical reaction between a solid (ion exchanger) and a fluid (usually a water solution) by means of which ions may be interchanged from one substance to another. The superficial physical structure of the solid is not affected. The customary procedure is to pass the fluid through a bed of the solid, which is granular and porous and has only a limited capacity for exchange. The process is essentially a batch type in which the ion exchanger, upon nearing depletion, is regenerated by inexpensive brines, carbonate solutions, etc. Ion exchange occurs extensively in soils.

Ion-exchange resins are synthetic resins containing active groups (usually sulfonic, carboxylic, phenol, or substituted amino groups) that give the resin the property of combining with or exchanging ions between the resin and a solution. Thus, a resin with active sulfonic groups can be converted to the sodium form and will then exchange its sodium ions with the calcium ions present in hard water.

Some specific applications of ion exchange: Water softening, milk softening (substitution of sodium ions for calcium ions in milk), removal of iron from wine (substitution of hydrogen ions), recovery of chromate from plating solutions, uranium from acid solutions, streptomycin from broths, removal of formic acid from formaldehyde solutions, demineralization of sugar solutions, recovery of valuable metals from wastes, recovery of nicotine from tobacco-dryer gases, catalysis of reaction between butyl alcohol and fatty acids, recovery and separation of radioactive isotopes from atomic fission, chromatography, establishment of mass micro standards, in cigarette filters to remove polonium from smoke.

See also zeolite.

**ion-exchange chromatography.** A chromatographic method based on the ability of polymers

to sorb ionized solutes reversibly, e.g., cross-linked resins with exchangeable hydrogen or hydroxyl ions. It can be carried out both in columns and on sheets.

**ion-exchange resin.** See ion exchange.

**ion exclusion.** The process in which a synthetic resin of the ion-exchange type absorbs non-ionized solutes such as glycerine or sugar while it does not absorb ionized solutes that are also present in a solution in contact with the resin. Thus, sodium chloride and glycerine can be separated by passage of their aqueous solution through a bed of particles of an ion-exclusion resin.

**ionic bond.** (electrovalent bond). Refers to the formation of ions by transfer of one or more electrons from one atom to another. See bond, chemical.

**ionic detergent.** See detergent.

**"Ionite" [Alpco].** TM for a lignite-type material.

Use: Oil-well drilling muds, as low-density filler in dark-colored rubber, as an organic base filler for fertilizers, and as a source of humic acid.

**ionization.** A chemical change by which ions are formed from a neutral molecule of an inorganic solid, liquid, or gas. The most common type of ionization occurs when an ionically bonded inorganic compound such as sodium chloride or sulfuric acid is dissolved in water (or other solvent), and the molecule separates or dissociates into two ions, the metallic ion being positively charged by loss of an electron and the nonmetallic ion being negatively charged by gaining an electron. The degree of dissociation varies with the type of compound, the solvent, and the temperature. Molecules or atoms of gases are ionized by passage of an electric current through the gas; this removes electrons and leaves a positive charge.

Compounds that ionize in solution greatly increase the conductivity of the solvent. Ionization is most effective in water because its high dielectric constant lowers the ionic bonding forces in the solute molecules enough to cause separation of their constituent atoms. Ion formation produces a notable rise in the boiling point and a depression of the freezing point of water. An electric current passed through a solution containing ions causes them to move to the oppositely charged electrode; this effect is the basis of many industrial electrochemical operations, such as electroplating and the manufacture of sodium hydroxide and chlorine.

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